CLAIMS

What is claimed is:

1. A droplet ejecting apparatus comprising:

a droplet ejecting head including:

a vibration plate;

an actuator for displacing the vibration plate;

a cavity filled with a liquid and having an interior pressure to be increased and decreased by a displacement of the vibration plate; and

a nozzle communicating with the cavity and for ejecting the liquid as a droplet depending upon an increase and decrease of the pressure within the cavity;

a drive circuit for driving the actuator; and

an ejection abnormality detecting device having a residual vibration detecting device for detecting residual vibration of the vibration plate displaced by the actuator after the actuator is driven by the drive circuit, to detect an abnormality of droplet ejection depending upon a vibration pattern of the residual vibration of the vibration plate detected by the residual vibration detecting device.

2. The droplet ejecting apparatus according to claim 1, wherein the ejection abnormality detecting device includes a determining device for determining a presence or absence of a droplet ejection abnormality of the droplet ejection head depending upon the vibration pattern of residual vibration of the vibration plate.

3. The droplet ejecting apparatus according to claim 2, wherein the determining device determines a cause of the ejection abnormality, when the presence of a droplet ejection abnormality is determined.

4. The droplet ejecting apparatus according to claim 3, wherein the vibration pattern of the residual vibration of the vibration plate includes a period of the residual vibration.

5. The droplet ejecting apparatus according to claim 4, wherein, when the period of the residual vibration of the vibration plate is shorter than a predetermined first period, the determining device determines that the cause of the droplet ejection abnormality is that there is an air bubble mixed in the cavity.

6. The droplet ejecting apparatus according to claim 5, wherein, when the period of the residual vibration of the vibration plate is longer than a predetermined second period but shorter than a predetermined third period, the determining device determines that the cause of the droplet ejection abnormality is that there is paper powder adhered to a vicinity of an exit of the nozzle, wherein the second period is longer than the first period and the third period is longer than the second period.

7. The droplet ejecting apparatus according to claim 6, wherein, when the period of the residual vibration of the vibration plate is longer than said predetermined third period, the determining device determines that the

cause of the droplet ejection abnormality is that there is a thickened liquid in a vicinity of the nozzle.

8. The droplet ejecting apparatus according to claim 2, further comprising a storage device for storing a result of the determination made by the determining device.

9. The droplet ejecting apparatus according to claim 1, further comprising a switch device for switching, after a droplet ejecting operation by the actuator, the actuator from the drive circuit to the ejection abnormality detecting device.

10. The droplet ejecting apparatus according to claim 1, wherein the residual vibration detecting device has an oscillation circuit, the oscillation circuit oscillating based on a capacitance component of the actuator varying depending upon the residual vibration of the vibration plate.

11. The droplet ejecting apparatus according to claim 10, wherein the oscillation circuit comprises a CR oscillation circuit having a capacitance component of the actuator and a resistance component of a resistance element connected to the actuator.

12. The droplet ejecting apparatus according to claim 10, wherein the oscillation circuit has an oscillation frequency configured one figure higher than a vibration frequency of the residual vibration of the vibration plate.

13. The droplet ejecting apparatus according to claim 10, wherein the residual vibration detecting device includes an F/V conversion circuit for generating a voltage waveform of the residual vibration of the vibration plate from a predetermined signal group generated based on an oscillation frequency change in an output signal of the oscillation circuit.

14. The droplet ejecting apparatus according to claim 13, wherein the residual vibration detecting device includes a waveform shaping circuit for shaping a voltage waveform of the residual vibration of the vibration plate generated by the F/V conversion circuit into a predetermined waveform.

15. The droplet ejecting apparatus according claim 14, wherein the waveform shaping circuit includes a DC component removing device for removing a direct-current component from a voltage waveform of the residual vibration of the vibration plate generated by the F/V conversion circuit, and a comparator for comparing between a voltage waveform removed from the direct-current component by the DC component removing device and a predetermined voltage value, the comparator generating and outputting a rectangular wave depending upon the voltage comparison.

16. The droplet ejecting apparatus according claim 15, wherein the ejection abnormality detecting device includes a measuring device for measuring a period of the residual vibration of the vibration plate from the rectangular wave generated by the residual vibration detecting device.

17. The droplet ejecting apparatus according claim 16, wherein the measuring device has a counter, the counter counting pulses of a reference signal to thereby measure a time between at least one of rising edges of the rectangular waves, and rising and falling edges of the rectangular waves.

18. The droplet ejecting apparatus according to claim 1, wherein the actuator comprises an electrostatic actuator.

19. The droplet ejecting apparatus according to claim 1, wherein the actuator comprises a piezoelectric actuator utilizing a piezoelectric effect of a piezoelectric element.

20. A droplet ejecting head ejection abnormality detecting/determining method comprising the steps of:

detecting residual vibration of a vibration plate after carrying out an operation for ejecting a liquid within a cavity as a droplet from a nozzle by driving an actuator to vibrate the vibration plate;

detecting a droplet ejection abnormality; and

determining a cause of the droplet ejection abnormality depending upon a detected vibration pattern of the residual vibration of the vibration plate.